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On the Reproduction of *Gobiosoma robustum* Ginsburg.

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(Plates I & II; Text-figure 1).

INTRODUCTION.

The small and active goby, *Gobiosoma robustum* Ginsburg, inhabits a wide range of territory on the west coast of Florida near the field station of the New York Aquarium located on Palmetto Key. There appears to be nothing whatever in the literature on the habits or behavior of this common fish. The observations and data presented herewith were gathered incidental to studies of the life histories of other species in this region (see Breder 1939a and b, 1941a and b). Mr. M. B. Bishop of Yale University, Mr. L. A. Krumholz of the University of Illinois and Mr. B. Dontzin of Cornell University all rendered valued assistance in connection with this study.

This species, differentiated from related forms by Ginsburg (1933), represents the only member of the genus found occurring near the laboratory. Here it is abundant and may be taken in numbers among the mangrove roots and on open sandy beaches. Dredging brought it up from depths as great as twenty feet, which represents the deepest of this shallow bay in the vicinity of the laboratory. It was taken in such equipment over all of the various types of bottom, such as grassy places, sponge beds, scallop beds, sand bars and even over soft spots of flocculent mud.

The individuals of this form are exceedingly variable. Fowler (1941) figures six patterns represented in his material. Some of the pattern differences are referable to sex but they are so overlaid with individual vagaries that exact description becomes difficult. Nevertheless with a little experience it is possible to sex individuals with reasonable accuracy.

Shropshire (1932) figures the young of a *Gobiosoma* under the name *Gobiosoma moles-tum*. It is impossible to tell just which form, under present terminology, he had. *G. moles-*

tum Girard is now a synonym of *G. bosci* (Lacépède) but as Shropshire thought his material was not the latter it is possible that he was actually dealing with *G. robustum* as here understood.

There is no confusion about the identity of the present material as the fish were taken guarding their eggs and furthermore all other specimens in our collections are referable to this one species, and it is the only form definitely known to be living in the vicinity. Dr. I. Ginsburg, the describer of *G. robustum*, was good enough to check over this material and compare it with his large series of both species.

NESTING AND NESTING SITES.

Gobiosoma robustum may be found with its eggs from March to June, at least. At first this finding led to the assumption in the field that there were more than one species included. However, since a critical study of the incubating fishes shows them to be referable to a single species, it follows that this form has a long spawning period which reaches from the coldest to the warmest period of the year. It may well be that actually spawning is in progress at all times, which, if true would account for the relatively small number of nests encountered at any one time, compared with the abundance of individuals in the region.

The nests so far located have all been in shells or sponges. Usually the eggs are found hanging from the underside of some surface, but are not necessarily in such a position. Plate I, Figure 1, shows the two valves of a *Pecten* shell with the eggs attached to what had been the lower shell and the guarding male with them. This fish continued caring for the eggs with the shell in its open position.

COURTSHIP AND PARENTAL CARE.

Apparently only the males guard the eggs, as females have never been found in

the vicinity of nests. The males fan and work over the eggs in a manner reminiscent of a fresh water darter. Beyond this nothing was noted in the matter of specialized behavior. Although the males would attack small animals, such as other gobies, the slightest disturbance of a larger sort would usually cause them to retire. They would return as soon as the disturbance subsided.

Although we were not successful in having this species spawn in aquaria, several males established themselves in sheltered places which they would defend against the intrusion of their tank mates. From such locations they would sally forth to court nearby females. This was done with much spreading of the fins, especially the dorsal, accompanied by short darts near or at the female. This was usually carried on until she retreated. The coloration of the male at these times became intense and dark, nearly black, in most cases; most notably so on the widely extended first dorsal fin.

The largest male seen was 34 mm. in standard length. This is the fish shown in Plate I. The smallest mature and ripe male seen was 16.5 mm. Ripe females examined ranged from 16.5 to 21.5 mm. Apparently the males not only reach a larger size but average somewhat larger than the females as well. Smaller individuals grading down to those of a few millimeters are present both summer and winter, again indicating a long if not continuous reproductive season.

THE EGGS.

The elongate eggs are attached by one end to a matted base of adhesive threads. They are evenly elliptical but there is an apparent seasonal difference in their proportions. Those taken in March average rather differently than those taken in June according to the following schedule, measured on living eggs and given in mm.

No. of eggs	Months	Length		Minimum	Average	Width	
		Average	Maximum			Maximum	Minimum
8	March	1.62—	1.70	1.55	0.62—	0.70	0.60
2	June	1.35	1.40	1.30	0.50	0.50	0.50
10	All	1.57	1.70	1.30	0.60	0.70	0.50

These differences would seem to be referable to seasonal effects, probably chiefly temperature, controlling the speed of development of the ovarian eggs. Another possible interpretation is that this is an expression of incipient speciation, starting first with a prolonged spawning season finally reaching over the extremes of summer and winter temperatures. Those fish most responsive to temperature variations, at either end of the long season, might be beginning to show slight differences in reproductive items, in this case egg size, finally leading to the establishment of two fairly distinct forms with, perhaps, intermediates

dropping out. In this connection the differences in the spawning times of *Opsanus tau* and *Opsanus beta* discussed by Breder (1941a) is suggestive.

The winter eggs are shown in six stages of development in Text-fig. 1. When first found they appeared as in "A," March 14 3:45 p.m. The yolk and germinal parts are opaque and slightly yellowish. The elliptical envelope is clear and without markings. Attachment is at one end by means of a tangled mass of adhesive strands. The nature of this material is better shown in the photographs of Pl. II. In many of the eggs the yolk was nearer to the upper tip than to the center. Numerous exceedingly small droplets, hardly visible at lower powers, were scattered over the surface of the yolk as indicated in the sketches. Twenty-two and a quarter hours later the eggs appeared as shown in Text-fig. 1, "B." At this stage the swelling of the large head was especially prominent. In an additional twenty-six and a quarter hours the embryo was well formed and appeared as in Text-fig. 1, "C." Both yolk and embryo presented an opaque appearance. After twenty and one-quarter hours more the embryo had reached the proportions shown in Text-fig. 1, "D." At no time was there a sufficient transparency to evidence much of the internal structure. The side view seen in Text-fig. 1, "E," when the egg was twenty-one hours more advanced, shows some of the vertebral fragmentations. By the time an additional twenty-seven and one-half hours had passed the heart was evident and beating slowly and the tail gave spasmodic twitches.

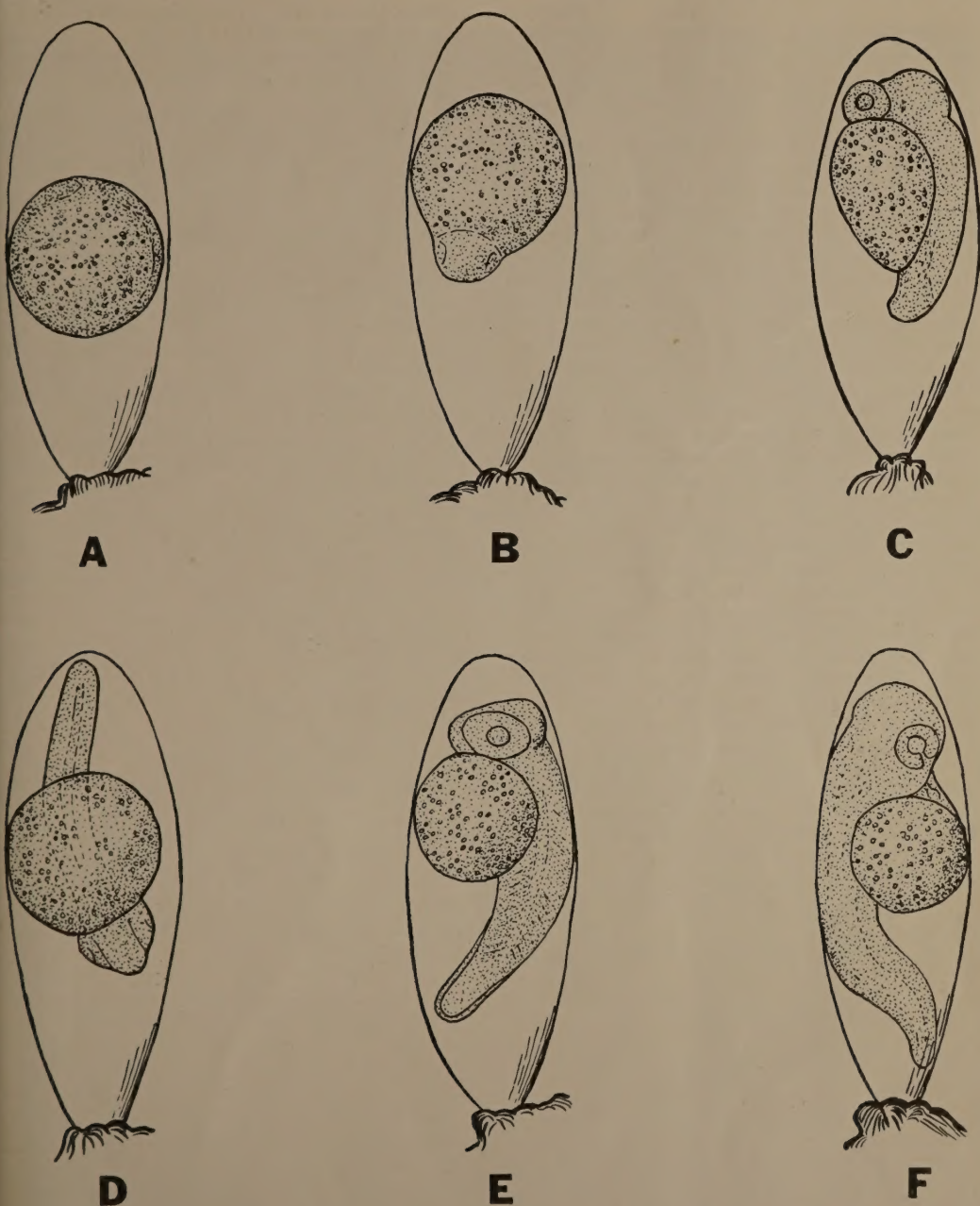
These figures cover a period of 117½ hours during which time the temperature in the incubating dishes ranged from 15.5 to 18.5° C. It was noted that some of the eggs were not as advanced as others, indicating at least more than one spawning. These fig-

ures are based on the youngest eggs. By the time the last stage was reached they were practically equal, so far as gross examination was concerned. Plate II, Figures 2 and 3, give some indication of the differences in the extent of advancement of the eggs, especially if compared with the sketches of Text-fig. 1.

By March 24 all the eggs were dead, presumably due to extreme temperature fluctuations in the laboratory.

DISCUSSION.

The development of the eggs of *Gobiosoma bosci* (Lacépède) has been described in de-



Text-fig. 1. Stages in the development of the eggs of *Gobiosoma robustum*. Camera lucida sketches of living material. A. An early egg as found in nest. B. 22¼ hours older than "A," with cephalization well advanced. C. 48½ hours older than "A," with the tail reaching well beyond the yolk. D. 68¾ hours older than "A." E. 89¾ hours older than "A." F. 117¼ hours older than "A," with the heart beating and the embryo showing activity.

tail by Kuntz (1916) and discussed at length by Hildebrand & Cable (1938). A comparison of the present notes on *G. robustum* with these papers shows the details to be quite similar, as would be expected on two

such close species. The eggs of the latter average slightly longer and wider than those of *G. bosci*, as is indicated by the following tabulation of ranges in size, given in mm.

Species		Long Diameter	Short Diameter
<i>G. bosci</i>		1.15-1.37	0.57-0.59
<i>G. robustum</i>	All	1.30-1.70	0.50-0.70
	Summer	1.35-1.40	0.50-0.50
	Winter	1.62-1.70	0.62-0.70

It will be noted that the summer measurements are closer to those of *G. bosci* than those of the winter. The *G. bosci* material was likewise taken in summer. Hildebrand & Cable (1938) found young from May to December on the North Carolina coast, indicating a long season for this species also but with a winter interruption which is probably more a matter of geography and temperature than a specific difference. This strengthens the view that spawning may take place throughout the year on the much warmer Florida west coast. They found the young sometimes in the surface tows but more frequently in the bottom tows, indicating that they do not spend much time as plankton, an item also noted in the *G. robustum* material. Dip nets have found them in very small sizes clinging to floating drift, such as bits of plant stems, and it seems that most specimens taken in surface tows come from such locations, as even in very small sizes they sink rapidly and are not given to much active swimming other than short darts between supporting objects. Apparently sustained swimming is a considerable effort for these fishes.

The eggs of *Gobiosoma* and a number of related genera are remarkably similar as are their reproductive habits and it would be pointless at this place to discuss the perhaps minor differences of uncertain clarity until much more is known in greater detail about more of the numerous species.

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EXPLANATION OF THE PLATES.

PLATE I.

- Fig. 1. Male *Gobiosoma robustum* guarding nest in an opened scallop shell.

PLATE II.

- Fig. 2. Photomicrograph of the living eggs in about the stage shown in Text-figure 1, A.
- Fig. 3. Photomicrograph of the living eggs in about the stage of Text-figure 1, E.



FIG. 1.

ON THE REPRODUCTION OF *GOBIOSOMA ROBUSTUM* GINSBURG.

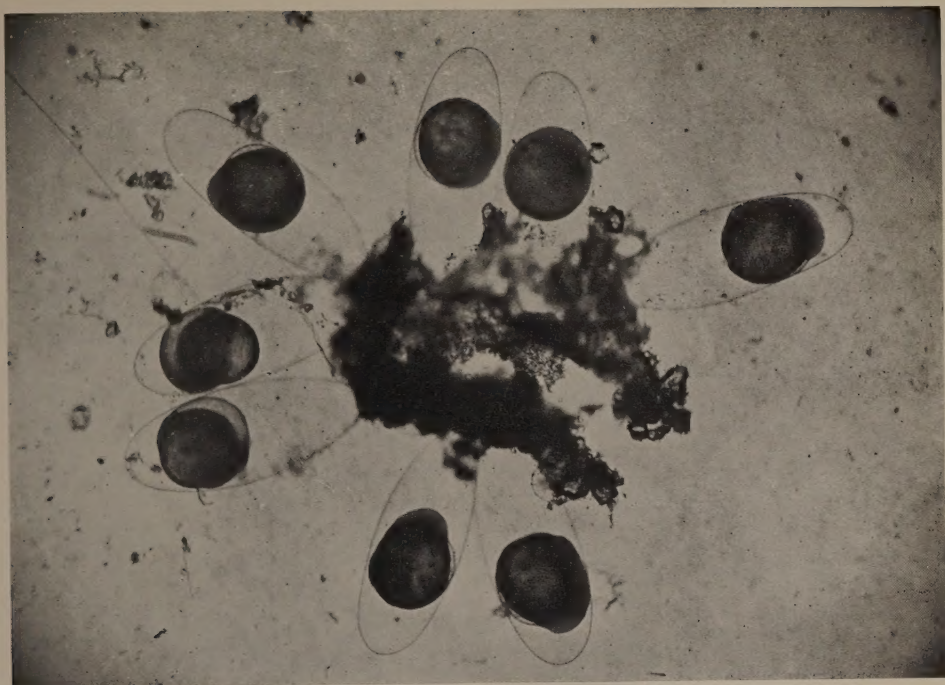


FIG. 2.

ON THE REPRODUCTION OF *GOBIOSOMA ROBUSTUM* GINSBURG.

